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GROWTH DEVELOPMENT OF KHASIA PINE IN BAW-LUANG PINE PLANTATION

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Growth development of Khasia pine in Baw-Luang Pine Plantation

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GROWTH DEVELOPMENT OF KHASIA PINE IN BAW-LUANG PINE PLANTATION

Abstract

The present investigation was basically aimed at obtaining the general information about the growth characteristics of Khasia pine, originated from the outstanding natural stand at Baw-Luang. The average survival percentages was 88.33%. The correlation between any tree characteristics compared showed statistically significances. Biomass production was estimated, based on the correlation equation between age and weight of dry matter of stem, branch, needle and root. Shoot/root ratio was found to decrease in relation to age.

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Acknowledgement

We would like to express our sincere thank to Kasetsart University for the research grant as well as to Dr. Pongsak Sahunalu, research coordinator of the master project, Silviculture 1.18.

We feel obliquely necessary to thank Mr. Samran Patanapirom for providing us facilities as well as to Mr. Vinit for his kind co-operation during the data collection in the field.

Introduction

Natural distribution of Khasia pine (Pinus kesiya) was well reported by Mirov (1967) to cover Khasia mountain range in India, northern part of Burma, between Sittang river and Salween river, northern part of Thailand and Laos, central and northern part of Vietnam (Critchfield and Little Jr. 1966). Khasia pine in the northern and central parts of Luzon in the Philippines was earlier be named as Pinus insularis (Anonymous 1954). Burley (1972) finally concluded that both Pinus insularis Endlicher and P. khasya Royle should be renamed as Pinus kesiya Royle ex Gordon.

Khasia pine stand in Thailand is generally quite small and grow scatterly in mixing with trees of the genus Shorea, Quercus, Castanopsis, and Dipterocarpus. It prefers less fertile soil, preferably acid soil, at high altitude between 200-1,300 m where annual rainfall is about 1,000-1,500 mm and average temperature between 22°-24°C. Boonyobhas (1968) reported that forest area in northern Thailand, about 1,350 square kilometers, was covered with pine. Only an area of 14 km^2 in the other part of the country, where pine grows naturally, was observed.

In most natural pine stands tree height ranged from 10 m upto 30 m with the average girth between 80-200 cm. Stem form was reported to be straight, surrounded with pale pinkish brown bark.

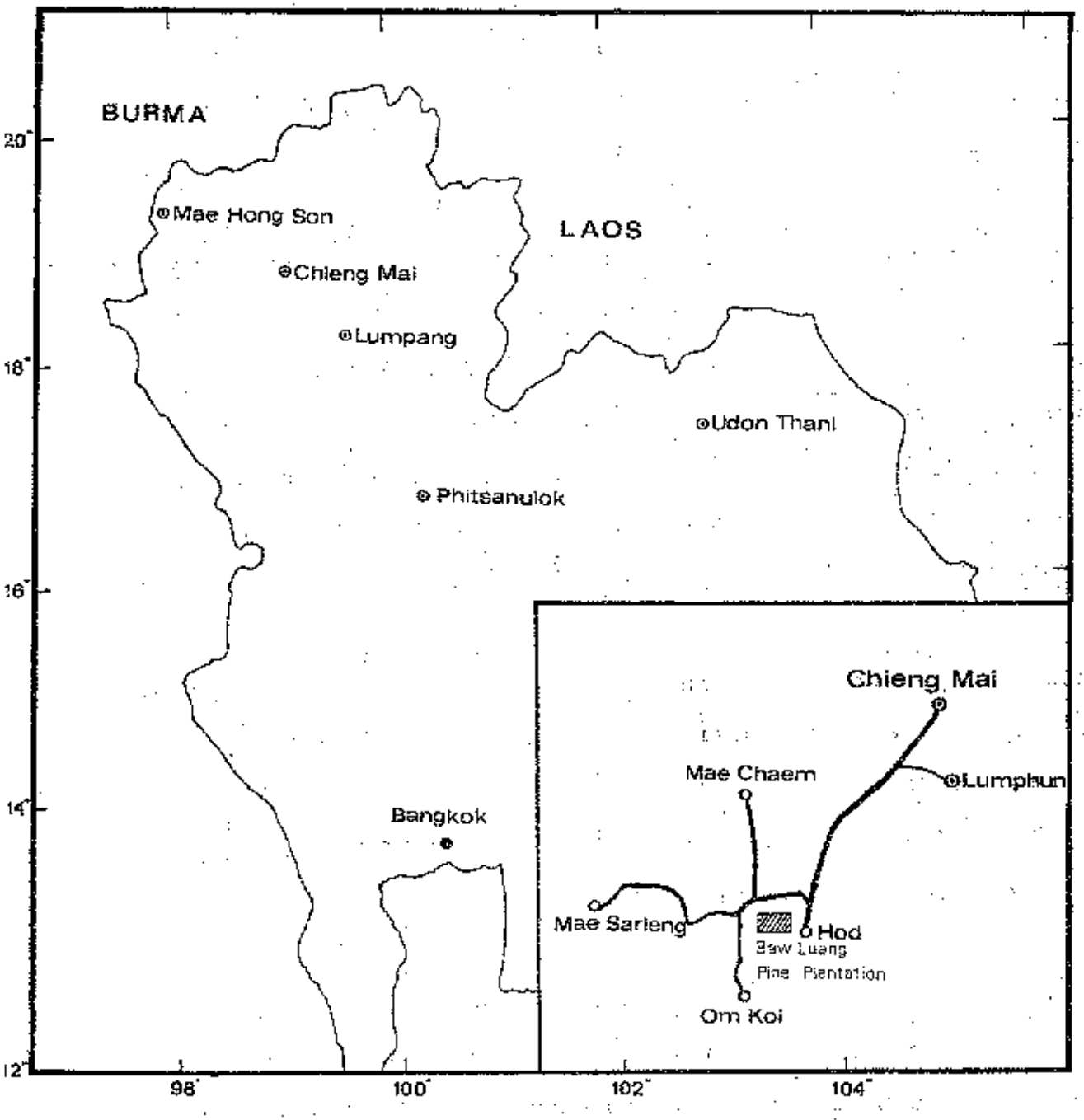


Figure 1. Location of Baw Luang Pine Plantation.

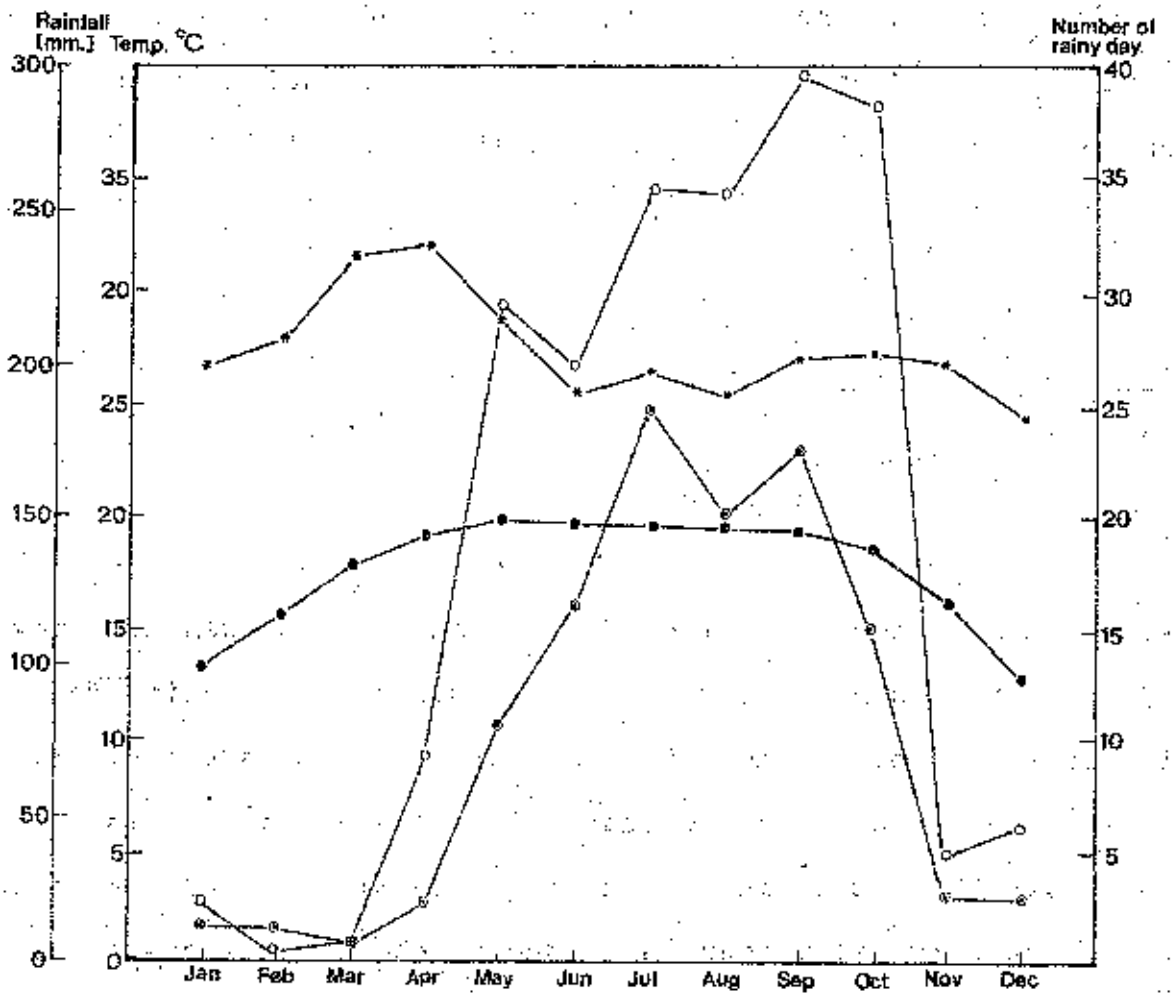


Figure 2. Monthly climatic data at Baw Luang Pine Plantation. (——*——Maximum temperature °C; —•——•—Minimum temperature °C; —*——*—No. of rainy day; —o——o—Rainfall (mm.)).

compared. This part of research was carried out in October-November, 1979.

Based on the growth curved two trees in each age class were selected to be cut down. Biomass of various tree parts, including stem, branch, root, and needle parts, was additionally studied. This part of research was done in June, 1980.

Results and discussion

1. Survival percentages

In establishing pine plantation, data on survival percentages may provide valuable informations about the success in planting fast growing trees. Table 1 indicated the differences in survival percentages of Khasia pine in Baw Luang Pine Plantation, ranging from 74.00% to 94.80%. According to Whitmore (1975), each tree species has different survival percentages, due to the differences in requirement on environmental conditions. This was particularly true for the development of seedlings of Baw Luang origin since plantation aging has no effect on the survival percentages.

Based on the study by Howcroft & Davidson (1973), survival percentages of Khasia pine seedlings of Baw Luang origin was found to be higher than those of Vietnam and Philippines origin. Nevertheless, survival percentages may decrease in relation to the number of

Table 1. Survival percentages in Baw Luang Khasia Pine Plantation

Age	Survival percentages
1	95.60
2	87.20
3	94.80
4	89.20
5	74.00
6	89.20
Average	88.33

years after establishment. Solberg (1978), for instance reported the decreasing of survival percentages of Khasia pine in Tanzania. It was dropped from 72.82% in the first year down to 24.50% in the third year.

2. Height growth

Height growth of Khasia pine was observed to change accordingly with age. The average height growth increased from 0.2-0.8 m in the first year upto 1.6-5.3 m in the sixth year. Comparison on height growth of seedlings originated from the same natural seed sources in various planting sites was shown in Table 2. Khasia pine grew in Papua-New Guinea performed the best height growth above all.

Table 2. Comparison on height growth of Pinus kesiya seedlings which originated from Baw Luang natural seed sources in various planting sites.

Age	Planting site						
	Baw Luang			Papua New Guinea	Nigeria	Tanzania	Zambia
	Present study	Arabo-retum trials	Crop perfor-mance trials	Howcroft& Davidson 1973	Ojo & Jackson 1973	Solberg 1978	Hans 1973
1	0.41	0.32	0.30	0.69	-	0.5	-
2	0.75	0.87	0.75	1.79	-	1.0	-
3	1.55	1.49	1.28	3.28	-	2.0	-
4	1.81	2.33	2.00	5.24	-	-	-
5	2.70	3.25	2.93	-	2.1-5.0	-	1.24
6	3.84	-	-	-	-	-	-

Eventhough variation in height growth between plots was detected, it was however possible to find the significant correlation between height growth and age (Figure 3). This was confirmed with the works done by Heiskanen (1965), Uusvaara (1974) and Chiba (1979).

Statistical significances was also observed between height growth in the year 1978 and 1979 (Figure 4).

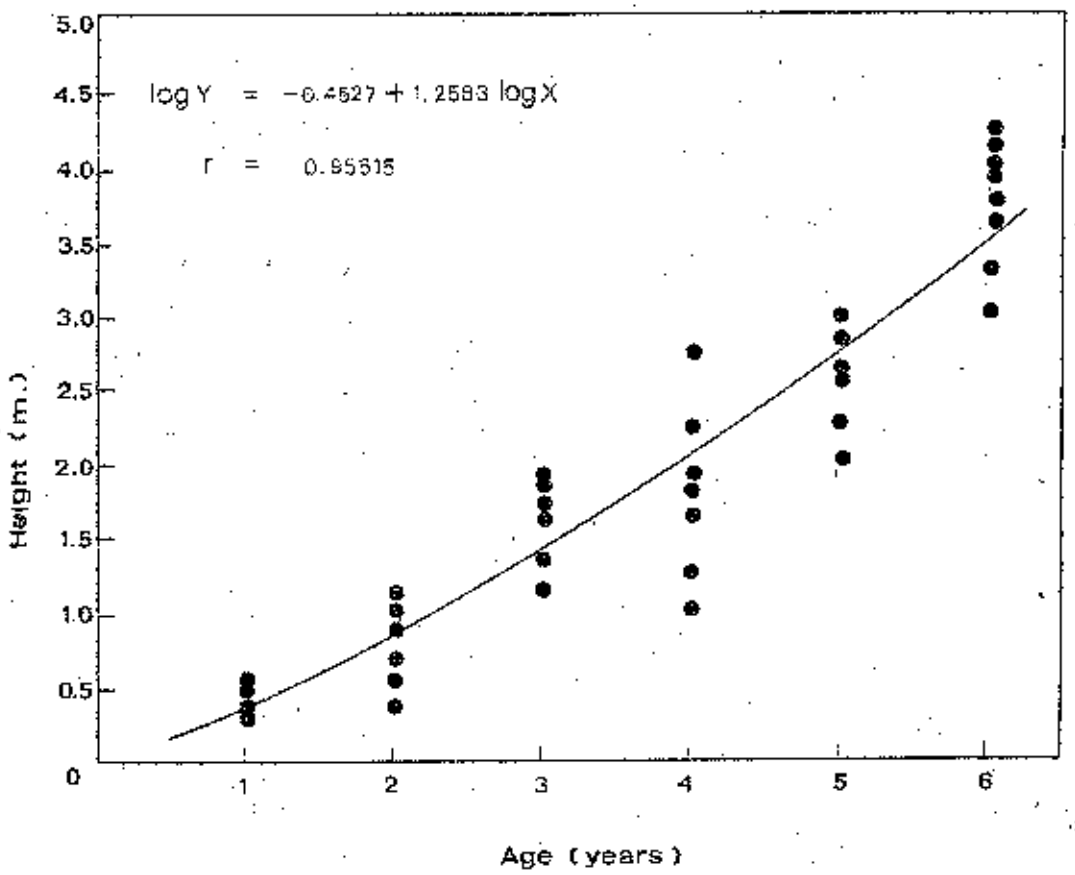


Figure 3. Relationship between age and height of Pinus kesiya.

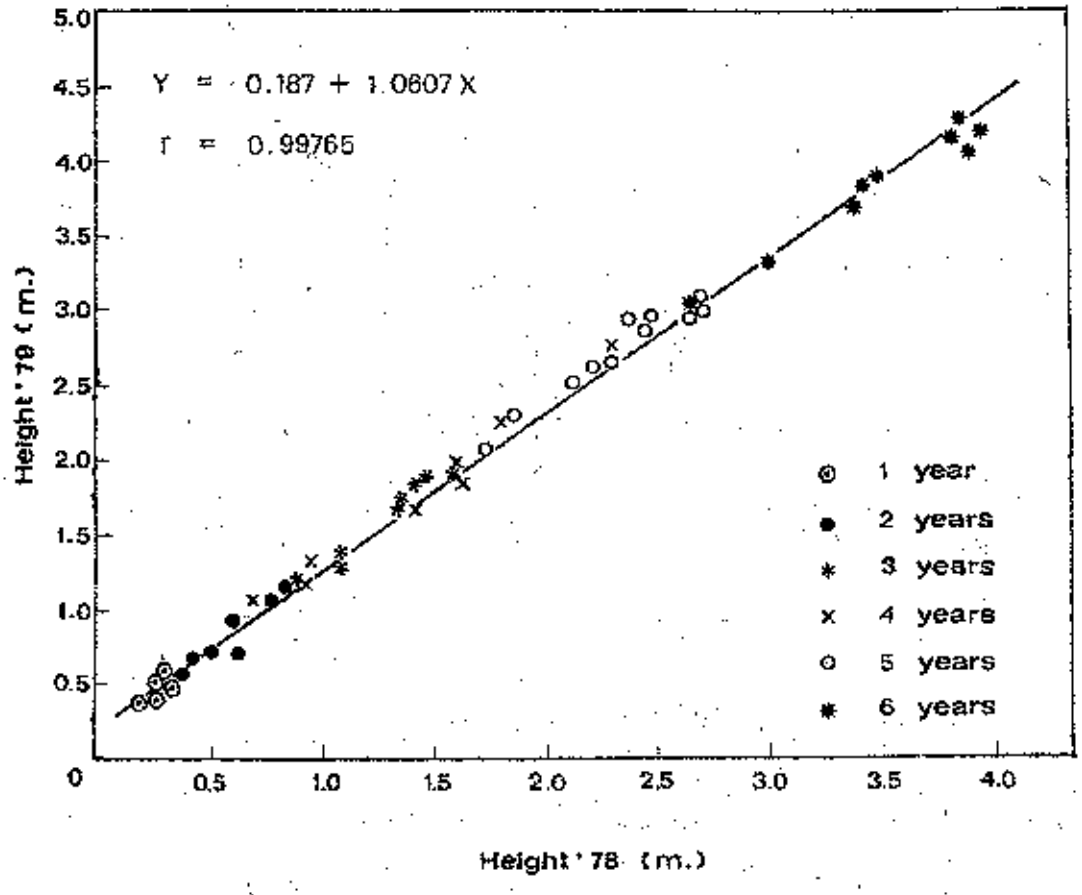


Figure 4. Relationship between height '78 and height '79 of Pinus kesiya.

3. Diameter growth

As regards diameter at breast height, the measurement could be done in the third year. However, significant correlation between diameter at ground level and diameter at breast height was found (Figure 5). Such significant correlation was also observed when comparing any of these characteristics with age factor (Figures 6 and 7).

Environmental factors may play some role in effecting the diameter growth of seedlings originated from the same seed source. In the case of Khasia pine originated from Baw Luang seed source, Howcroft and Davidson (1973) reported much bigger trees than those grown in its own origin.

Significant correlation between height growth and diameter growth was also established (see Figures 8 and 9).

4. Development of tree crown

The development of tree crown can be best studied by measuring crown diameter or crown length. Both crown diameter and crown length increased accordingly with age, performing significant correlation in both cases (Figures 10 and 11).

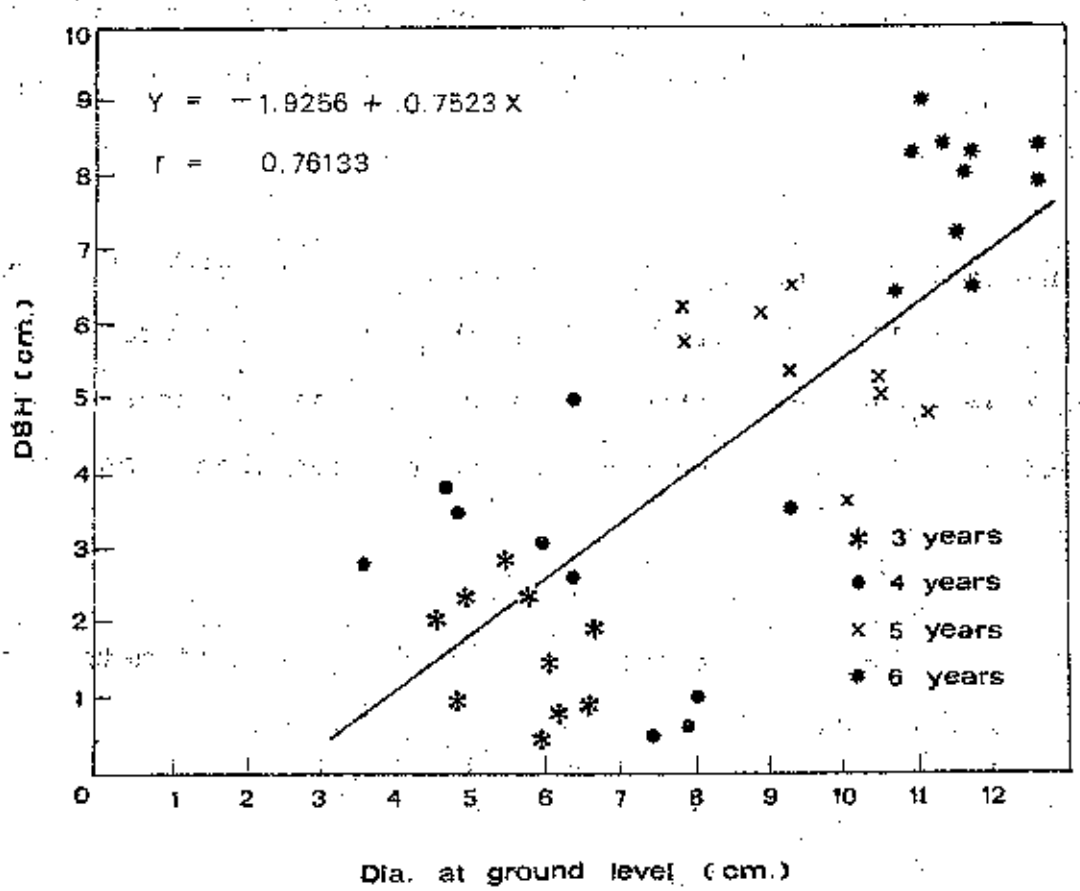


Figure 5. Relationship between dia. at ground level and DBH of Pinus kesiya.

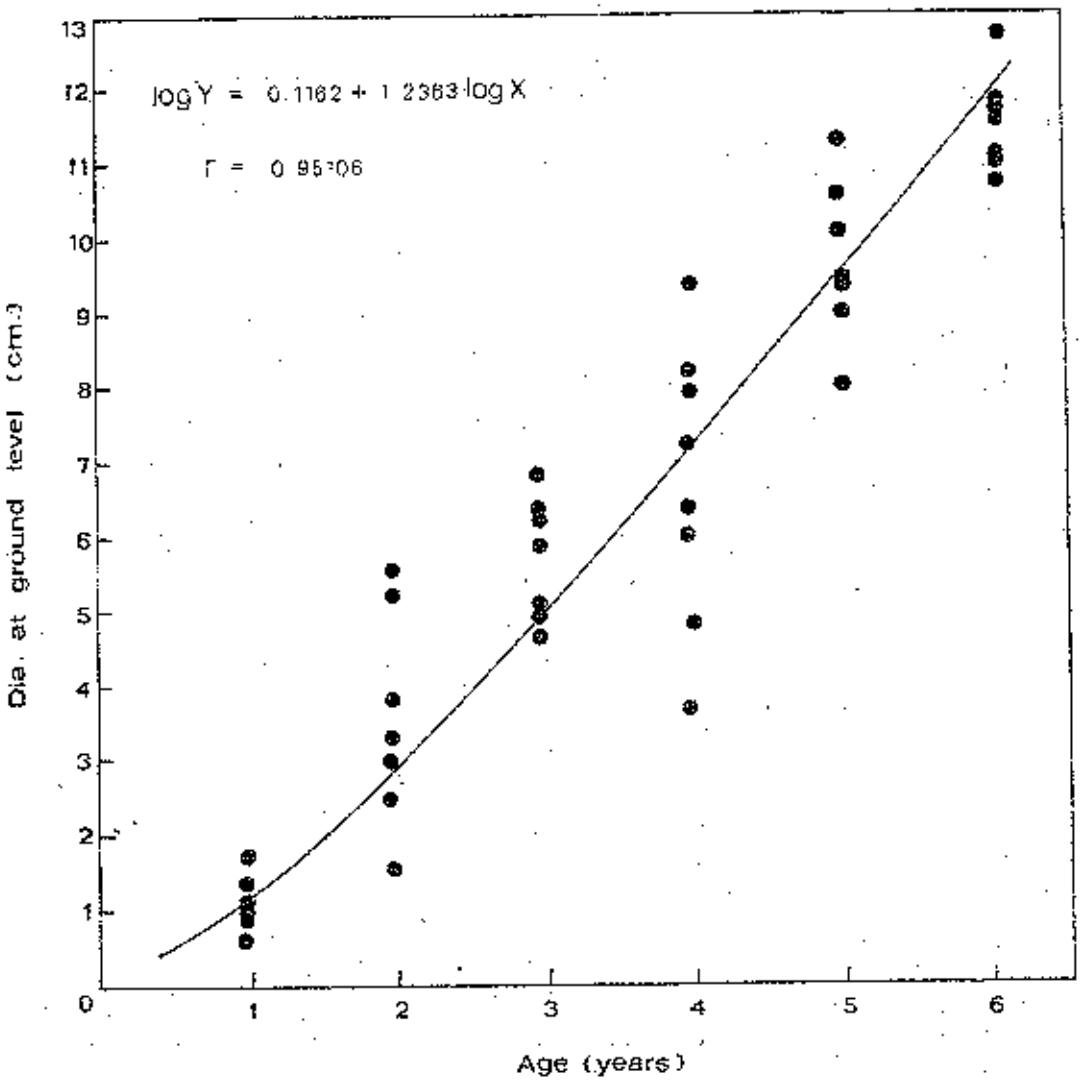


Figure 6. Relationship between age and diameter at ground level of Pinus kesiya.

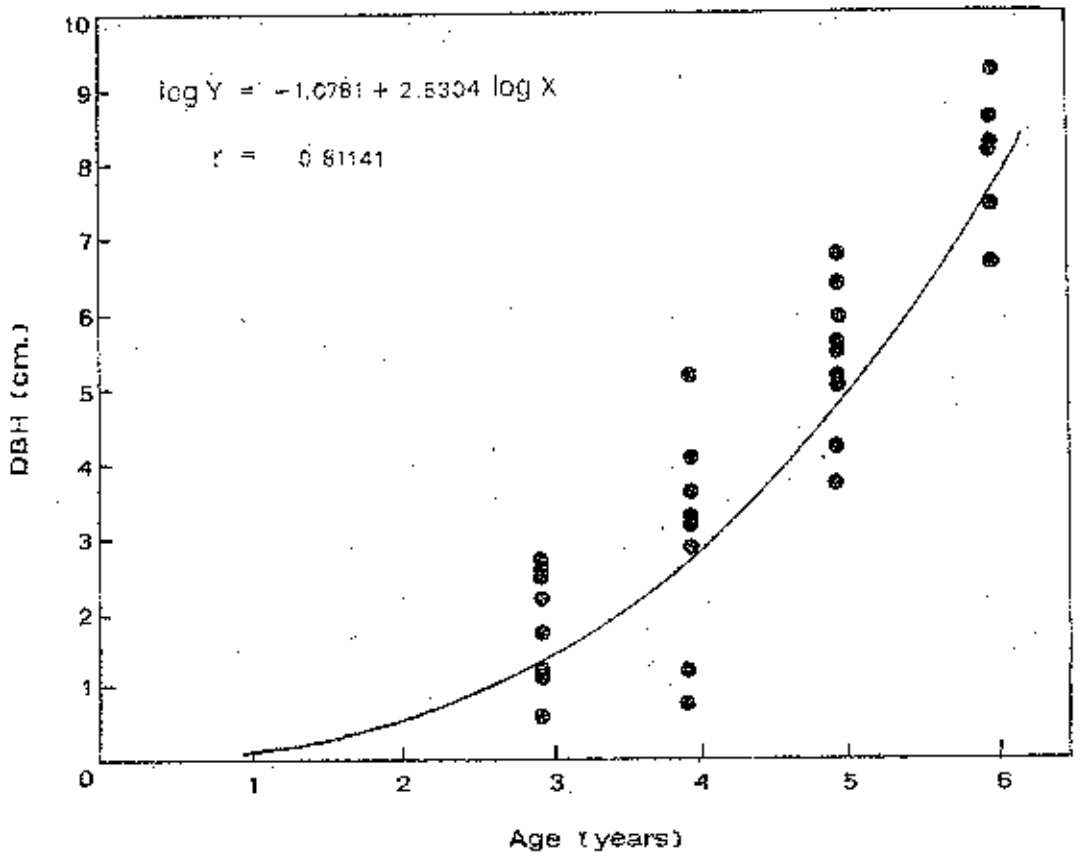


Figure 7. Relationship between age and DBH of Pinus kesiya.

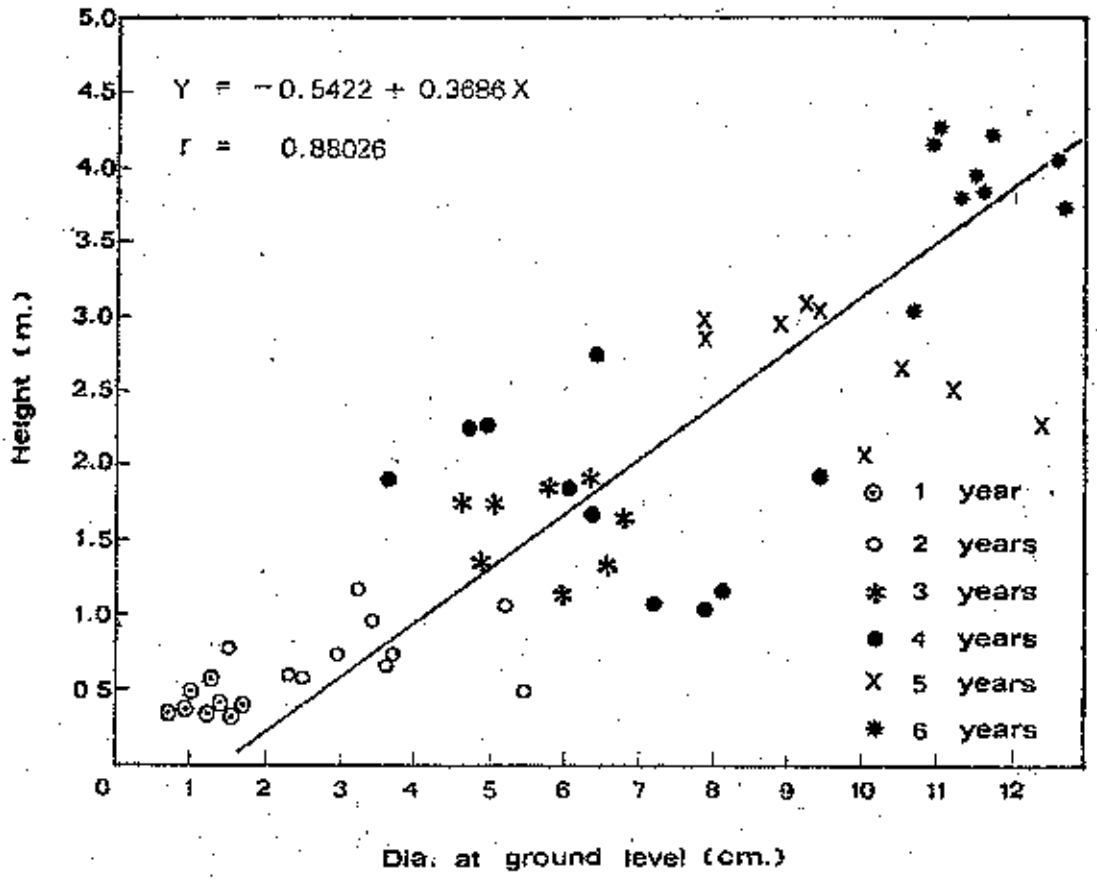


Figure 8. Relationship between dia. at ground level and height of Pinus keslya.

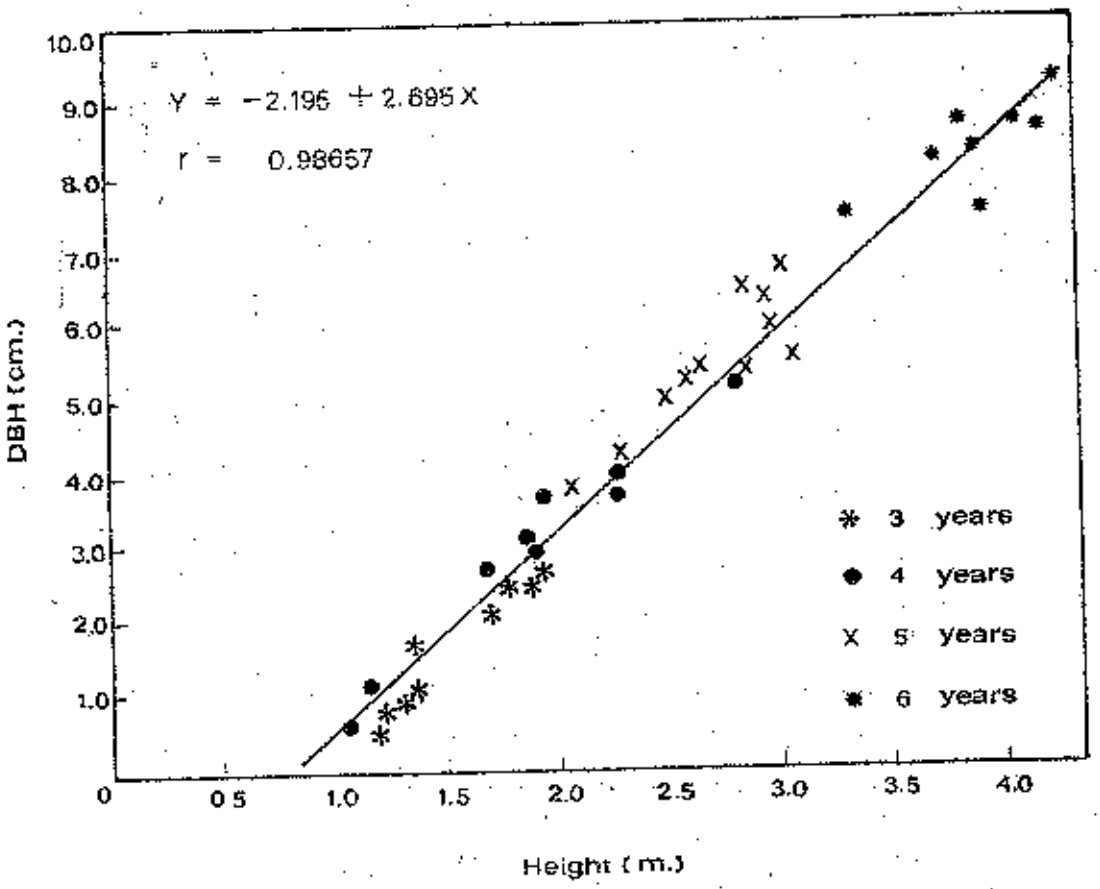


Figure 9. Relationship between height and DBH of Pinus kesiya .

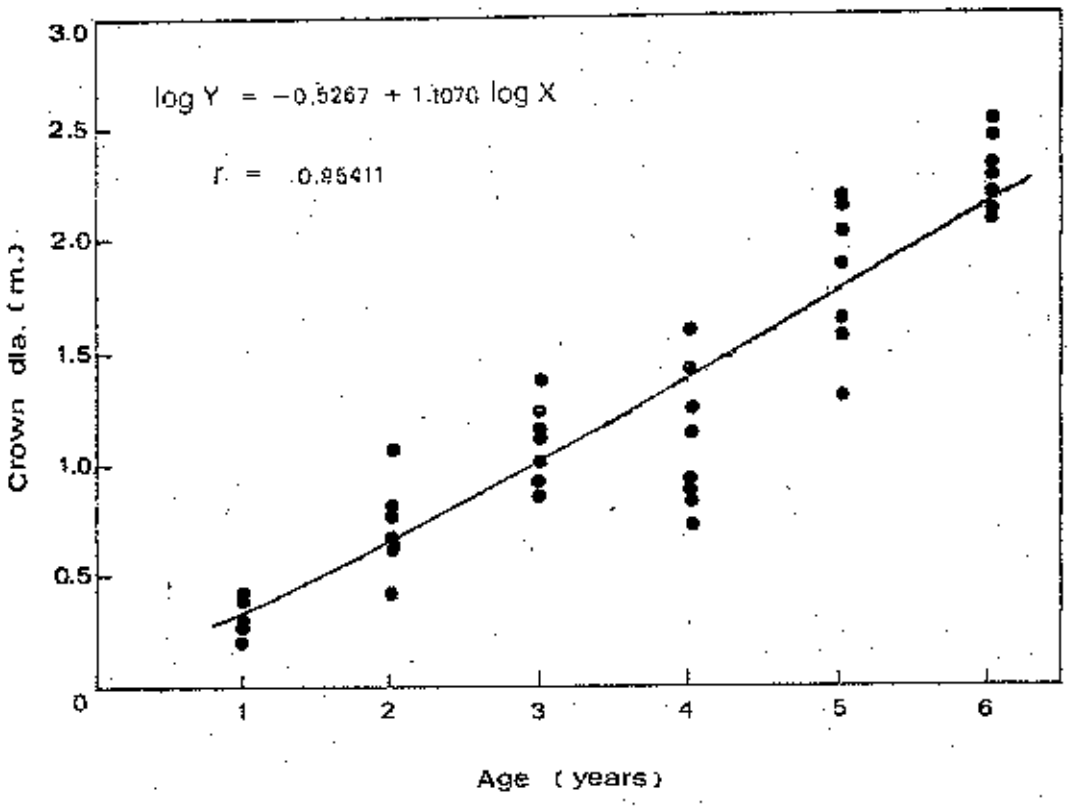


Figure 10. Relationship between age and crown diameter of Pinus kesiya.

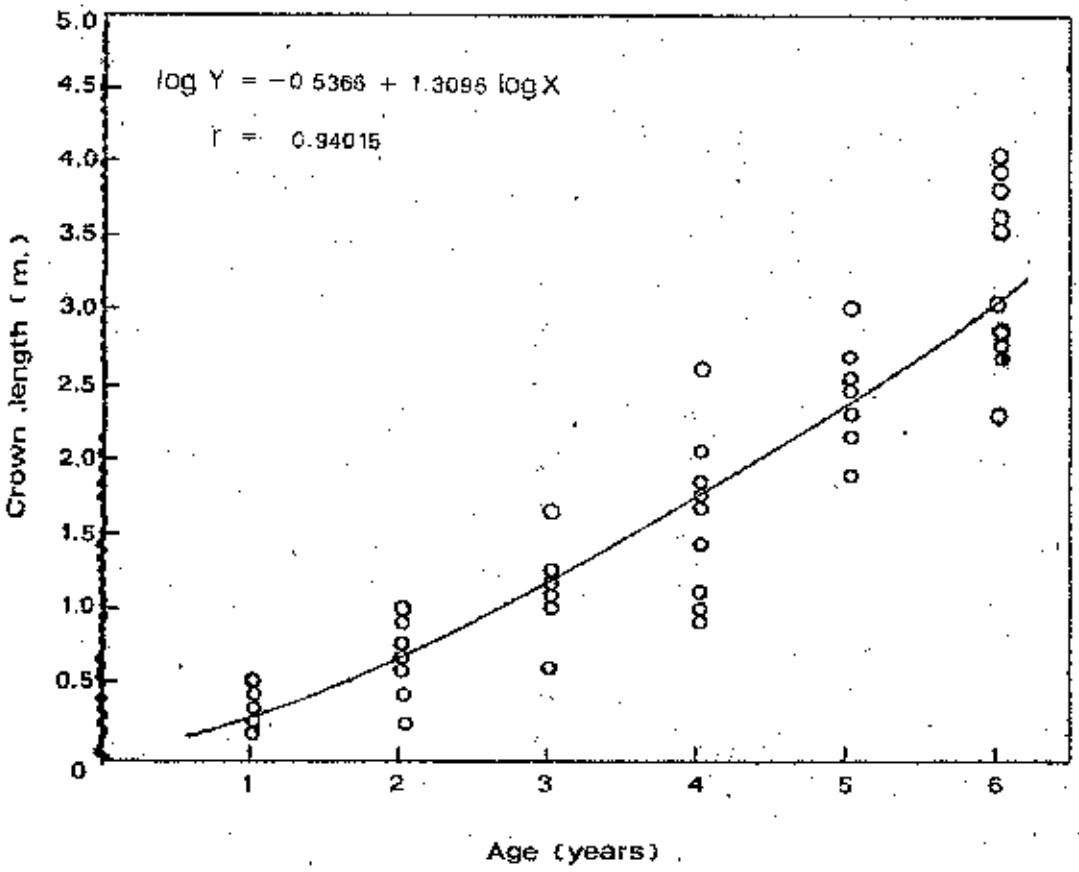


Figure 11. Relationship between age and crown length of Pinus kesiya.

Crown diameter actually based on its genetical background but spacing (Stiell 1966) and age (Uusuaara 1974) may influenced crown diameter.

Concerning to crown length, ratio between crown length and clear bole should varied depending on kind of tree species. The ratio between crown length and clear bole of Khasia pine were 4.07:1, 6.33:1,10.60:1, and 16.85:1 for seedling of 1, 2, 3, 4, and 5 years old respectively. This was confirmed very well with the previous research (Chiba 1979).

Figures 12, 13 and 14 indicated the significant correlation between crown diameter and DBH, crown diameter and height and crown length and height respectively.

5. Root development

Root development of Pinus kesiya was studied in more details. The root system of selected seedlings, having an average height of each age class, were investigated.

Two year old Khasia pine seedlings has already developed the tap root, ca. 12 cm long, and increased to be 1.40 m long in the sixth year (Figures 15-20). The diameter of root canopy increased accordingly with age, ranging from 20 cm in the first year upto 6.40 m in the sixth year.

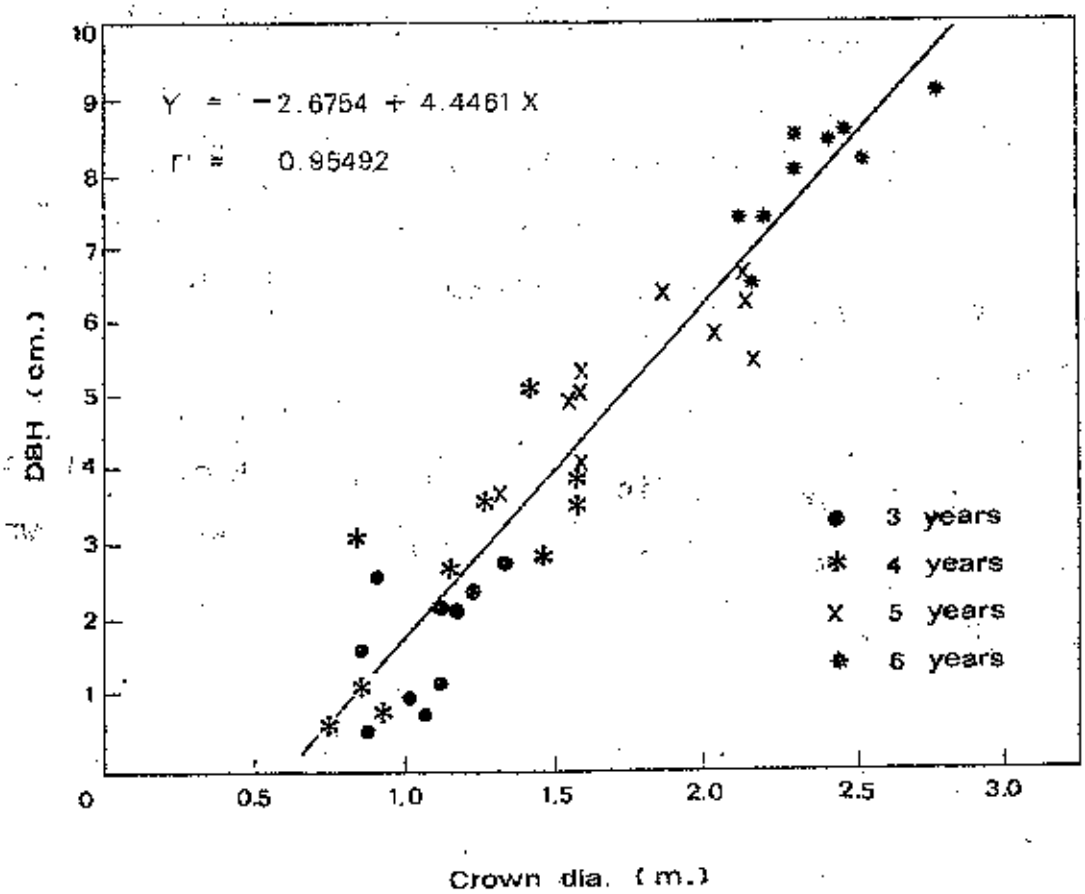


Figure 12 Relationship between crown dia. and DBH of Pinus kesiya.

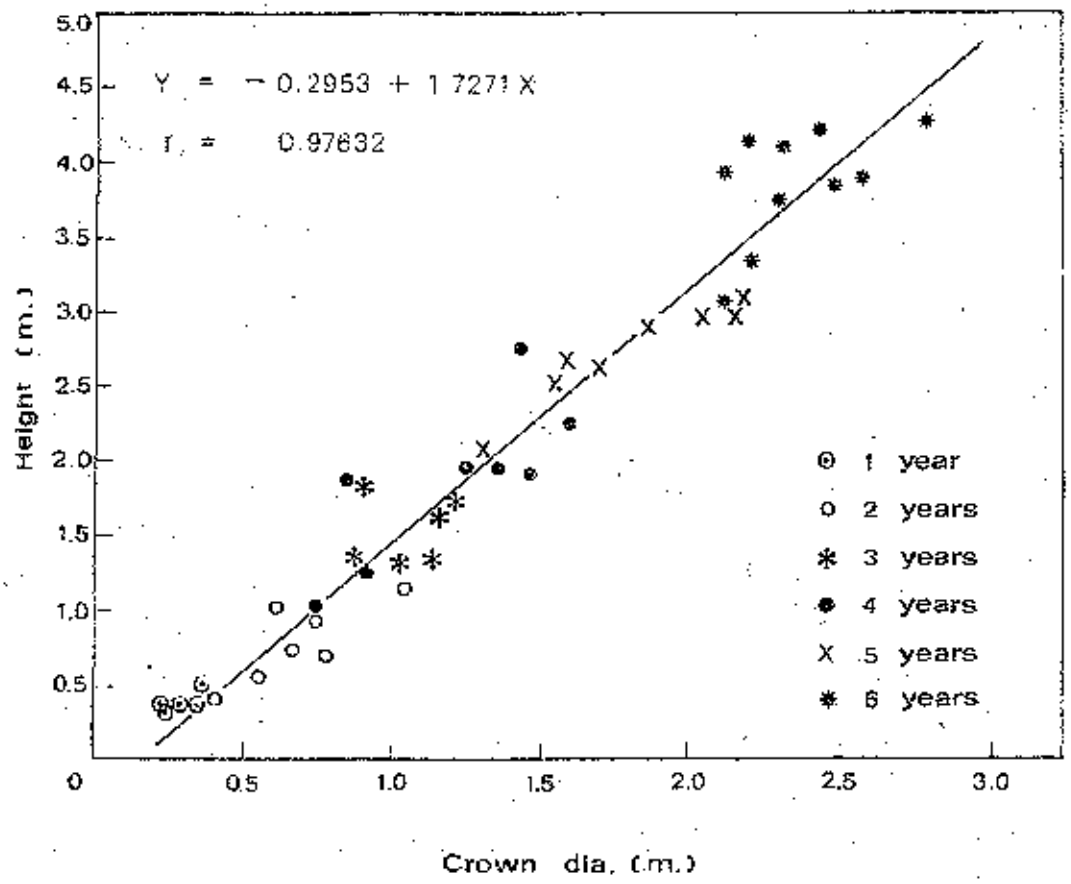


Figure 13 Relationship between crown dia. and height of Pinus kesiya.

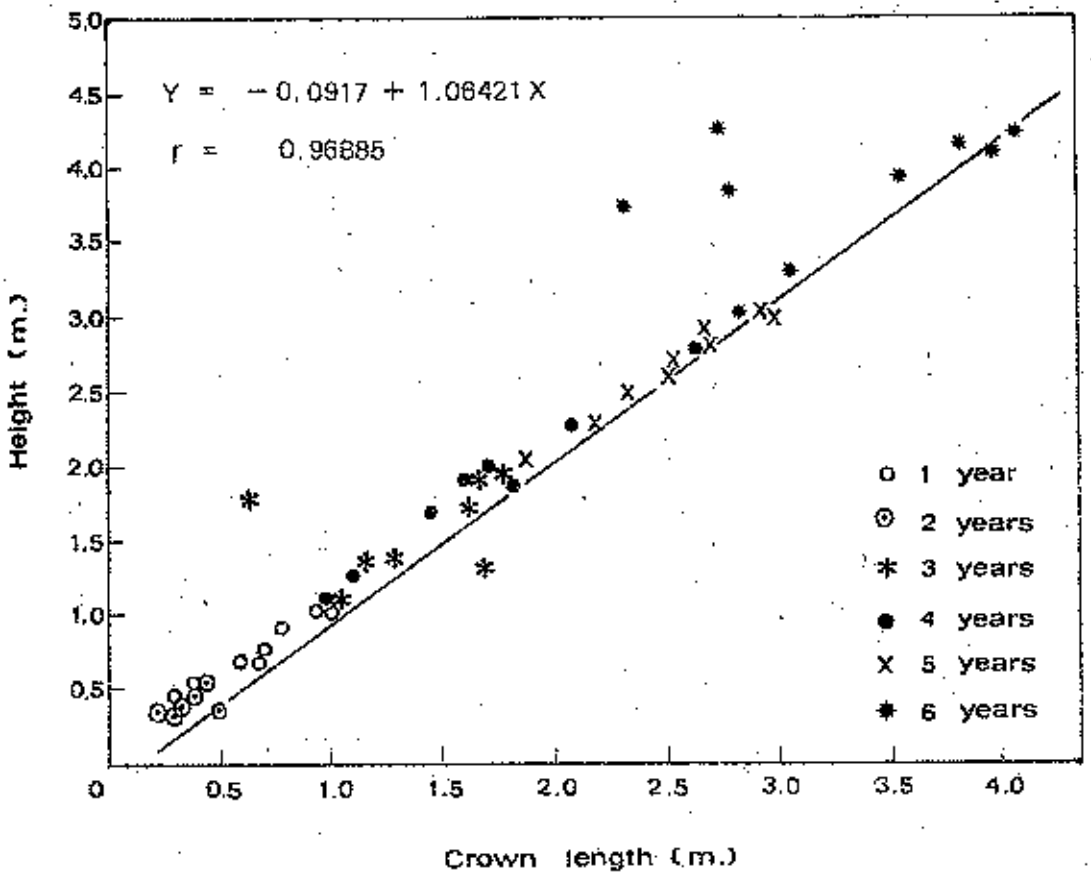
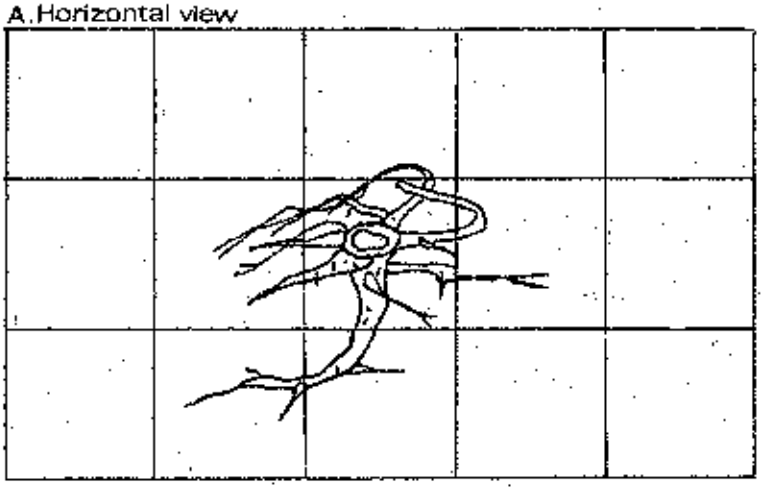


Figure 14. Relationship between crown length and height of Pinus keslya.

A.Horizontal view



B.Vertical view

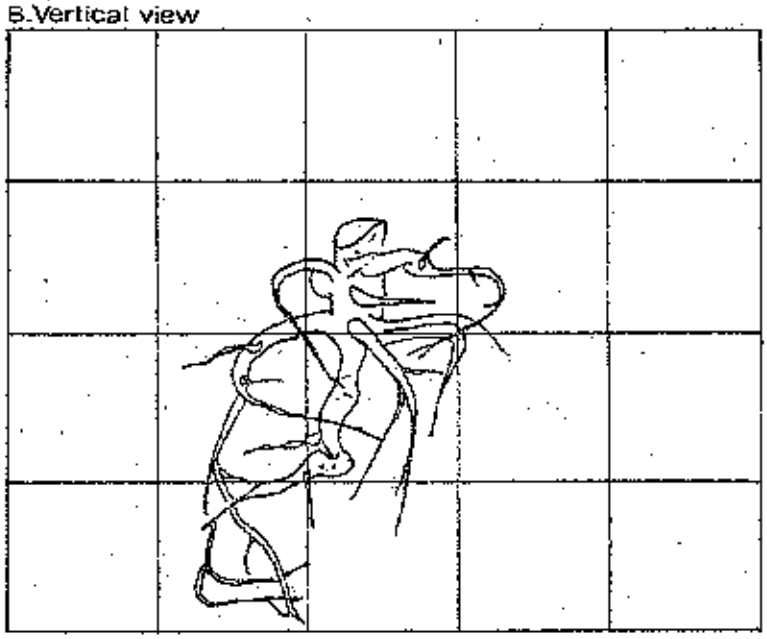
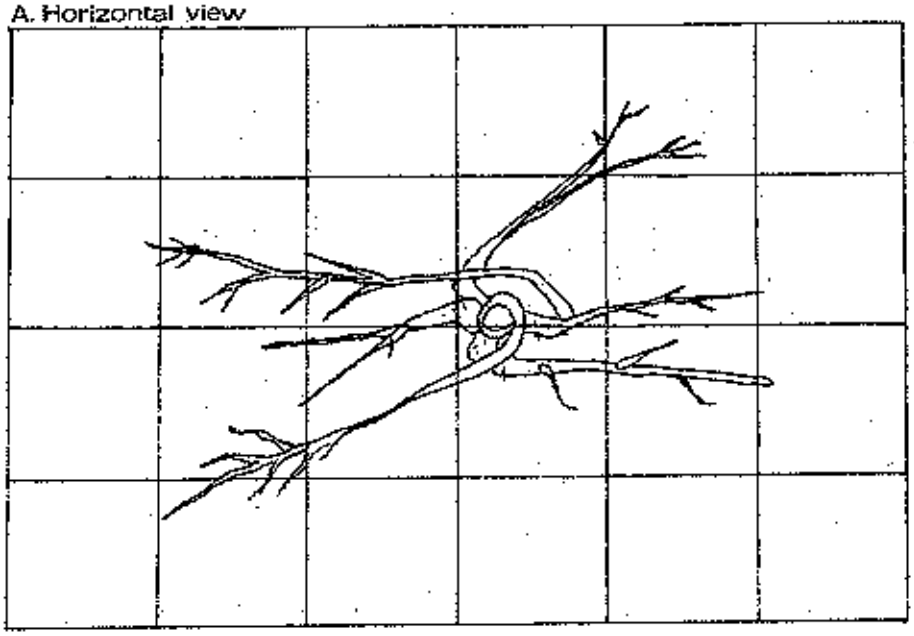


Figure 15. Root development of one year old seedling at Baw Luang Pine Plantation (scale 1 square : 10 x 10 cm^2).

A. Horizontal view



B. Vertical view

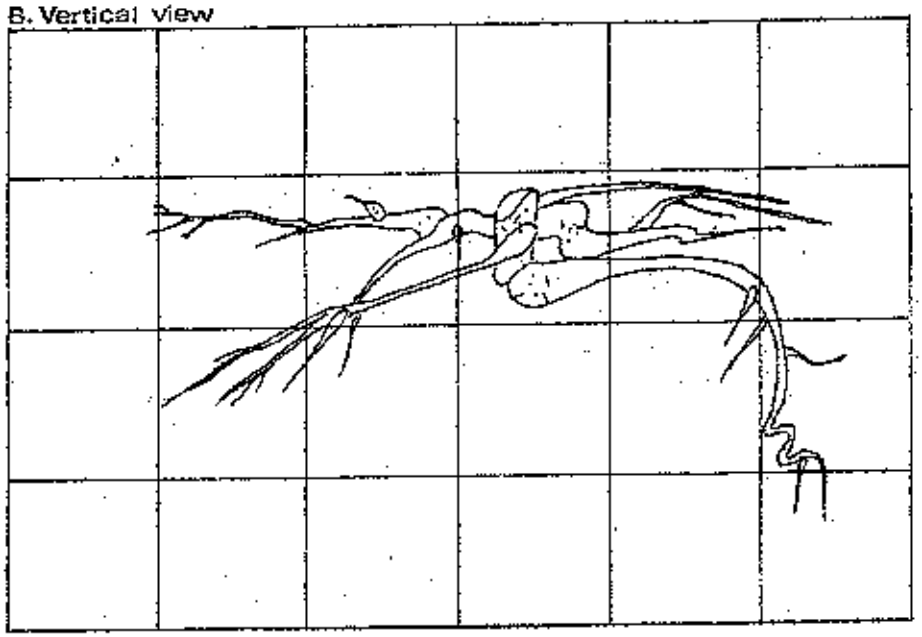
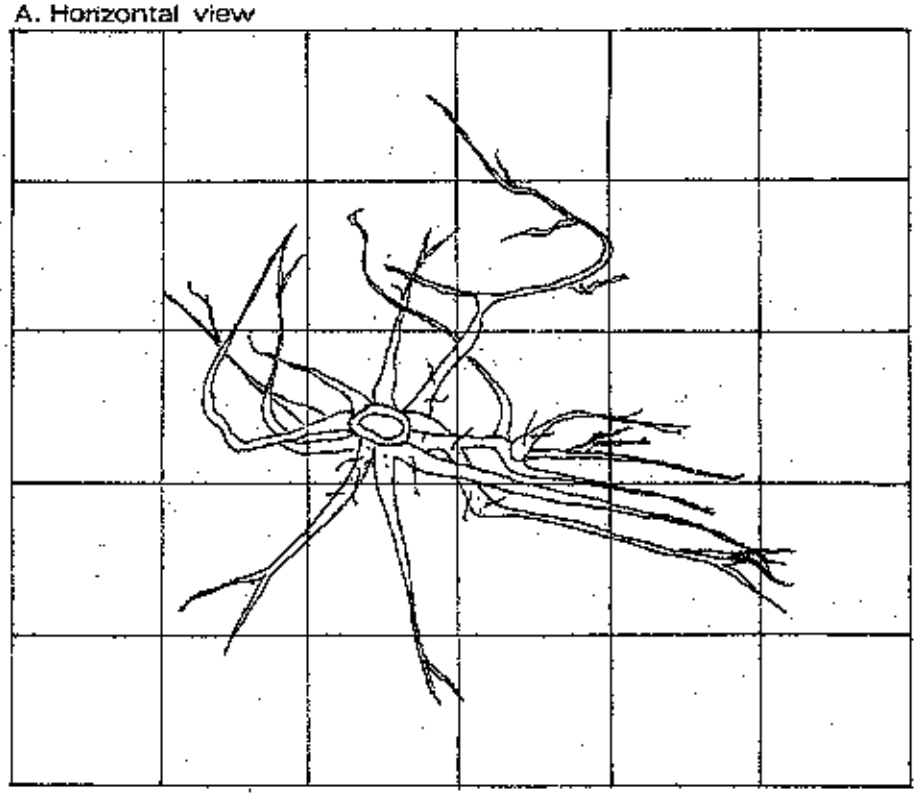


Figure 16. Root development of two years old seedling at Baw Luang Pine Plantation (scale 1 square : 20 x 20 cm^2).

A. Horizontal view



B. Vertical view

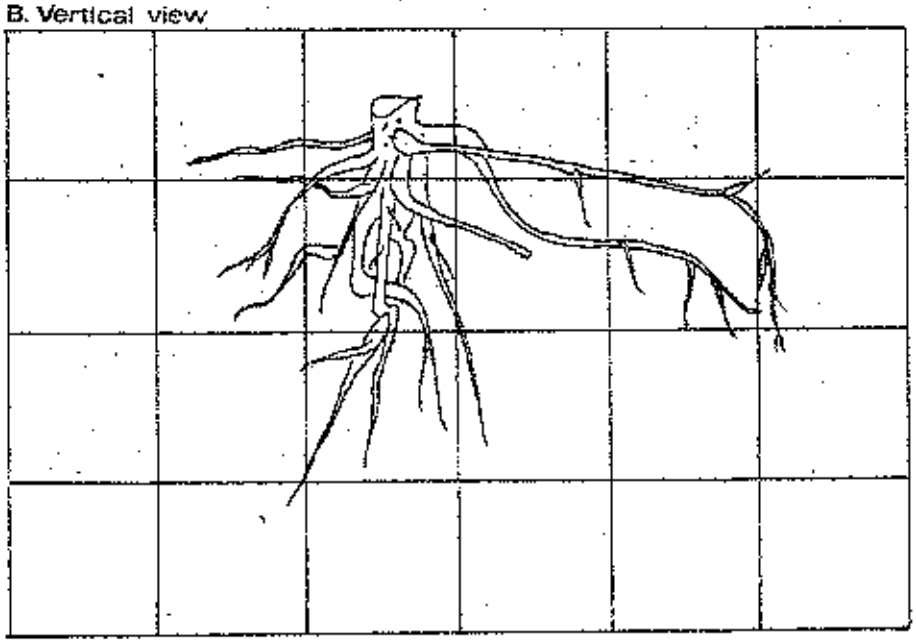
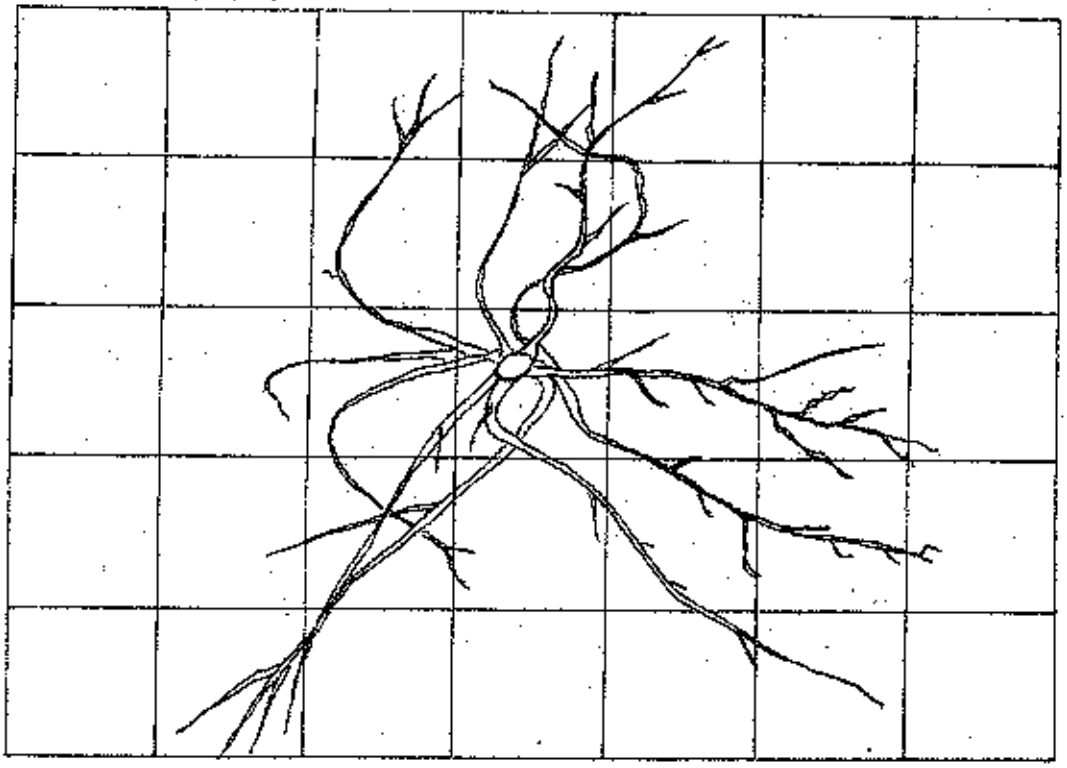


Figure 17. Root development of three years old seedling at Baw Luang Pine Plantation (scale 1 square : 40 x 40 cm^2).

A. Horizontal view



B. Vertical view

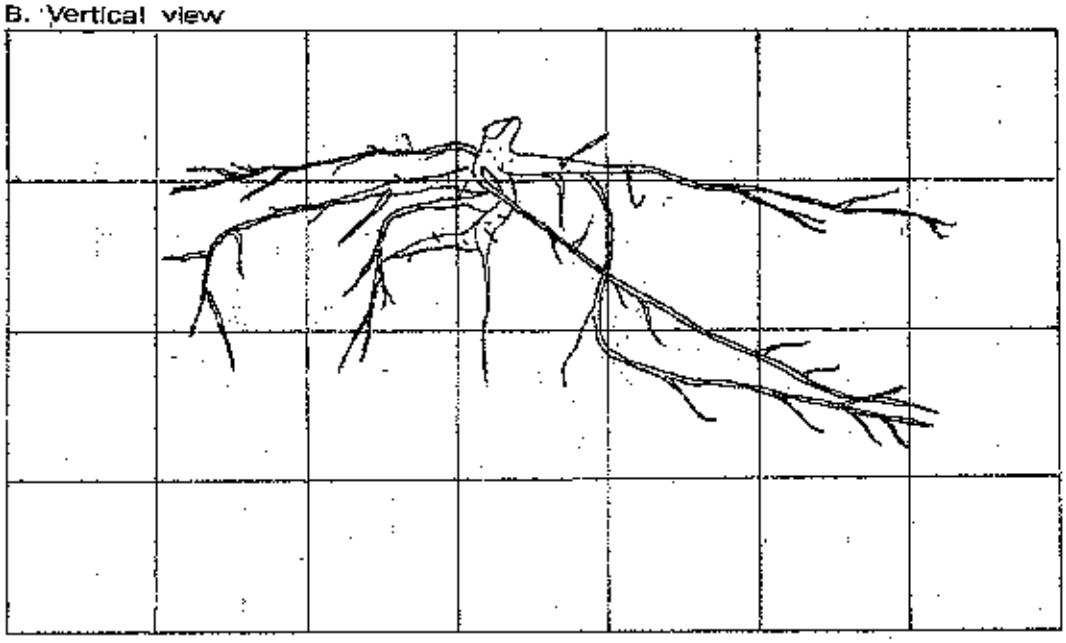
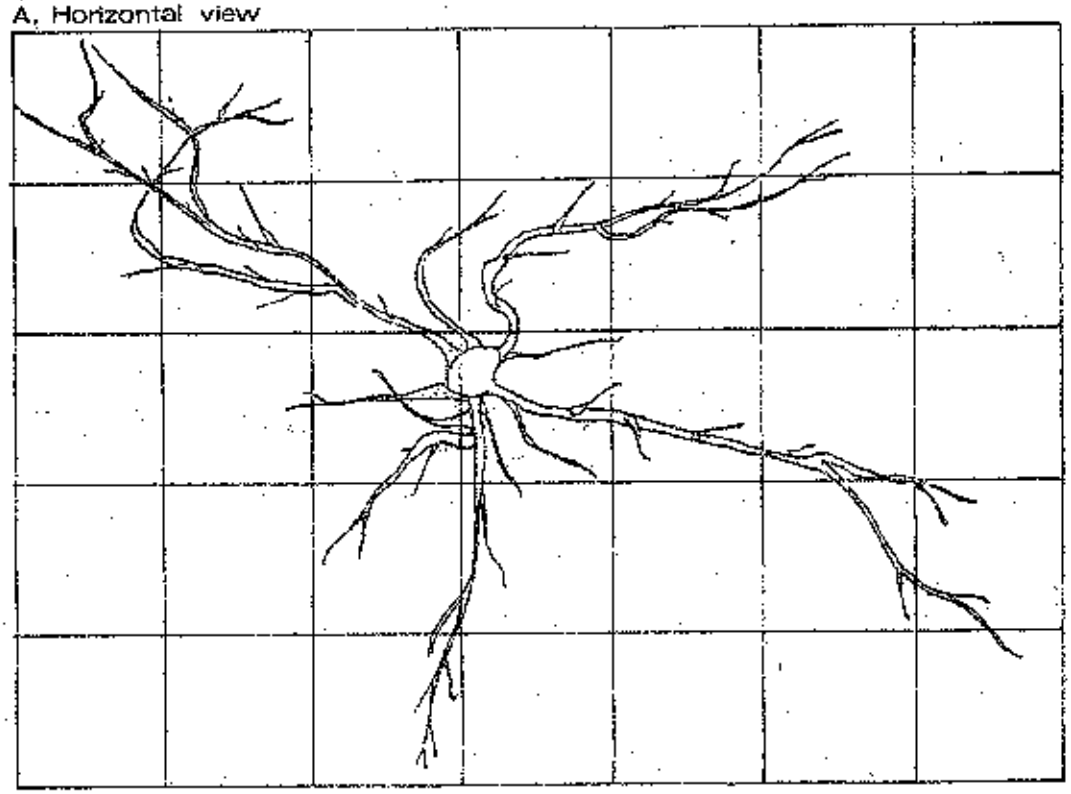


Figure 18. Root development of four years old seedling at Baw Luang Pine Plantation (scale 1square : 60 x 60 cm^2).

A. Horizontal view



B. Vertical view

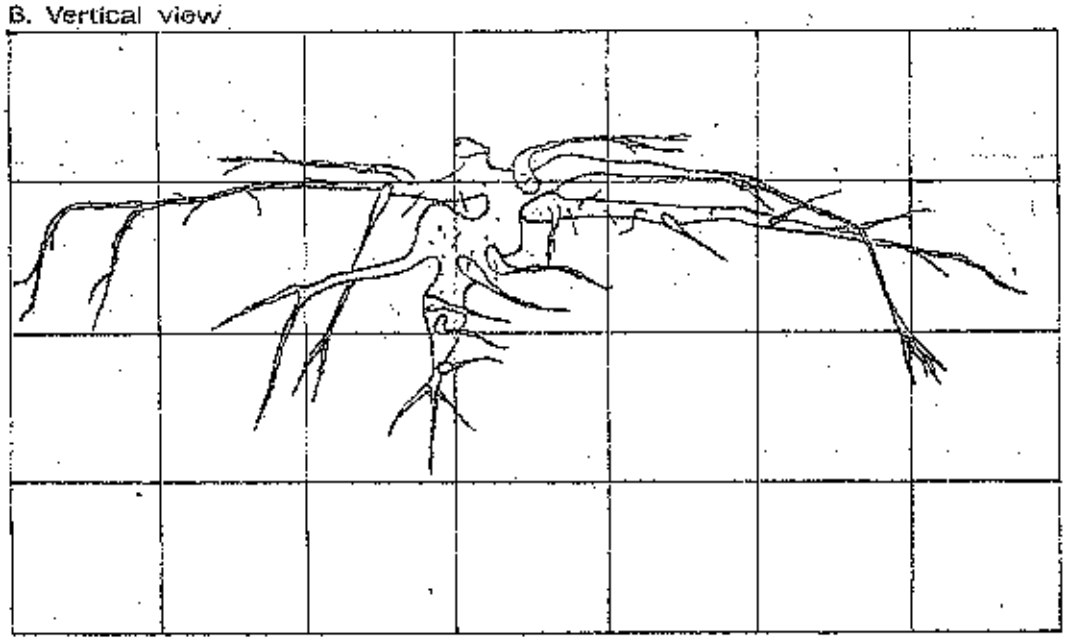
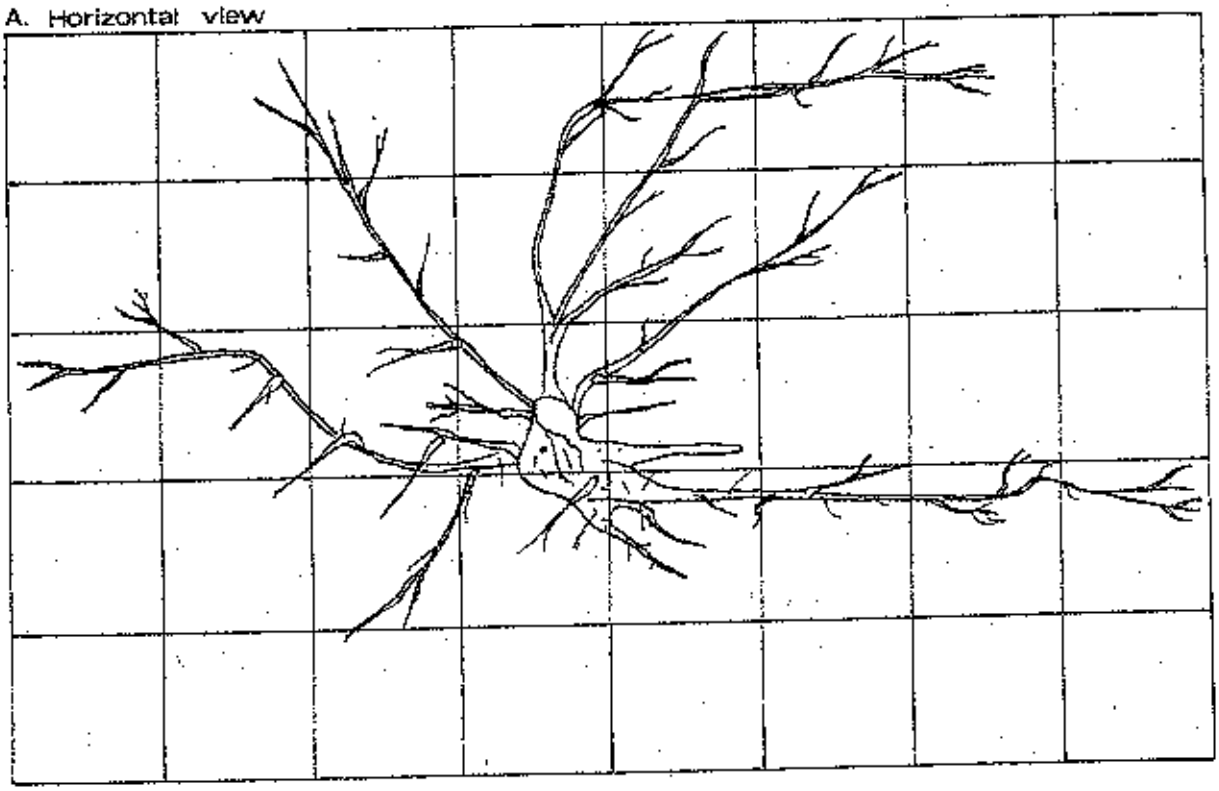


Figure 19. Root development of five years old seedling at Baw Luang Pine Plantation (scale 1 square : 70 x 70 cm^2).

A. Horizontal view



B. Vertical view

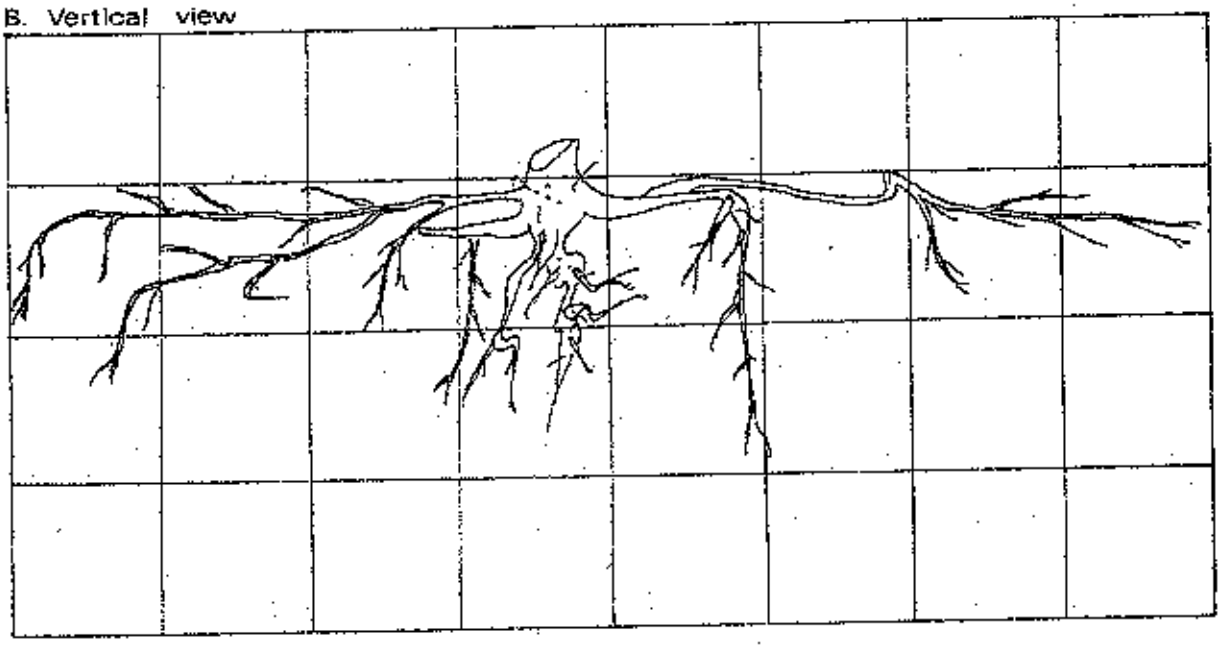


Figure 20. Root development of six years old seedling at Baw Luang Pine Plantation (scale 1 square : 80 x 80 cm^2).

As regards dry matters of root of Khasia pine, the correlation coefficient between age and dry matter of tap root or age and adventituous root were 0.81 and 0.98 respectively, with the correlation equations log y = -1.66234 + 2.51501 logx and log y = -2.26122 + 2.297247log x. When combining tap root and adventituous root together, the possible correlation equation will be log y = -0.56449 + 0.45504 log D^2H.

In fact, root dry weight increased in the first and second year and it was nearly constant in the third to the fifth year. This was similar to the work done by Sims (1964) who found nearly constant weight in the first four years.

The possible root dry weight matter, if calculated from each single sample plot seemed be rather high by which the production was increased from 0.4268 ton per hectare in the third year upto 3.0899 ton per hectare in the sixth year.

Regarding to the shoot/root ratio, as shown in Table 3, the value varied much in relation to age factor. In the first and second year, shoot dry weight was more than twice the root dry weight.

In the third to sixth year, shoot dry weight was found to be lesser than root dry weight. If the comparison was made between the above ground and under ground biomass (Table 4), the ratio tend to decrease in the third year.

Table 3. The shoot-root ratio of Khasia pine.

Age	Shoot growth kg/tree	Root growth kg/tree	Shoot/root
1	0.0142	0.0054	3 : 1
2	0.1111	0.0536	2 : 1
3	0.6779	0.6828	1 : 1
4	0.9378	0.7637	6 : 5
5	4.0592	1.2568	3 : 1
6	6.9311	4.9438	3 : 2

Table 4. Ratio aboveground and underground biomass ratio of Khasia pine.

Age	Aboveground biomass kg/tree	Underground biomass kg/tree	Ratio
1	0.0394	0.0054	7 : 1
2	0.3964	0.0536	7 : 1
3	1.8669	0.6828	3 : 1
4	2.3585	0.7637	3 : 1
5	6.2507	1.2568	5 : 1
6	15.6329	4.9438	3 : 1

6. Branch development

If Khasia pine seedlings normally developed without any silvicultural treatment or any damages, the number of branches will increased in relation to the age factor. Table 5 showed the branch number in each age class, ranging from 6 branches in the first year upto 37 branches in the sixth year.

Concerning to dry matter of Khasia pine branch in relation to age, the correlation coefficient was 0.86241 with the correlation equation, $\log y = -0.61361 + 0.46281 \log D^2H$. The possible dry weight increased from 0.0023 ton/hectare in the first year upto 3.1851 ton/hectare in the sixth year. The high value of branch biomass indicate the necessary in searching way of possible utilization.

Table 5. The average number of branch in each age class.

Age	Number of branch
1	5.799 ± 1.798
2	12.654 ± 3.183
3	20.664 ± 3.183
4	24.512 ± 6.229
5	34.523 ± 6.118
6	36.148 ± 7.008

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